REMARKS

Claims 24-42 are pending. Claims 1-23 have been previously cancelled. Claim 26 has been objected to under 37 C.F.R. §1.75(c) as being of improper dependent form. Claims 24-42 have been rejected under 35 U.S.C. §103. Claims 24, 35, and 41 have been amended. Support for the amendments to the claims is found in at least paragraphs [0020] and [0028] of the substitute specification. Claims 26 and 36 have been cancelled without prejudice. Claims 24, 25, 27-35, and 37-42 remain for consideration upon entry of the present Amendment. No new matter has been added.

The Examiner has objected to the abstract because of various alleged informalities.

Applicants have reviewed the alleged informalities as pointed out by the Examiner and have requested that a new abstract be substituted for the previous one. Accordingly, Applicants respectfully request that the Examiner withdraw the objection to the abstract.

The Examiner has objected to claim 26 under 37 C.F.R. §1.75(c) as being of improper dependent form for allegedly failing to further limit the subject matter of a previous claim. The Examiner has required the cancellation of the claim or the amendment of the claim to place the claim in proper dependent form or that the claim be rewritten in independent form.

Applicants have reviewed the alleged informalities as pointed out by the Examiner and have incorporated the subject matter of claim 26 into claim 24. Accordingly, Applicants respectfully request that the Examiner withdraw the objection to claim 26.

Claims 24-32 and 35-38 have been rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,844,959 to Van Swam et al. (hereinafter "Van Swam"). The Examiner notes that the composition of the zirconium-based alloy tube disclosed by Van Swam overlaps the composition of the composition of the instant invention, and that such is allegedly a prima facie case of obviousness, and that it would have been obvious to one of ordinary skill in the art at the time the invention was made to select the claimed amount of niobium for a zirconium-based alloy from the amount of niobium in the zirconium-based alloy disclosed by Van Swam because Van Swam allegedly discloses the same utility throughout the disclosed ranges.

The present invention concerns cladding tubes for nuclear fuel for a nuclear pressure water reactor (PWR). The operation conditions in a PWR are substantially different than those of a boiling water reactor (BWR). One type of cladding tube that is particularly

advantageous for a PWR is a cladding tube of a zirconium-based alloy where the only major alloying element is niobium. The present invention is concerned with such a cladding tube. This fact has now been made explicit in the amended independent claims, since it is now stated that no alloying element (except for the base material zirconium and the element niobium) has a content that exceeds 0.2 weight percent.

In the manufacture of cladding tubes of the prior art, normally a final anneal is carried out, such a final anneal generally being one in which a complete recrystallization is obtained. It was believed that advantageous properties were achieved by such a final anneal. However, the inventors of the present invention have surprisingly found that the properties of such cladding tubes can be improved if the final anneal is carried out in a different manner, e.g., such that the material of the cladding tube is only partly recrystallized (for example between about 40% and 95%).

Van Swam discloses zirconium alloys consisting essentially of from 0.5 to 3.25 weight percent niobium, from 0.3 to 1.8 weight percent tin, and the balance of the alloys being essentially nuclear grade zirconium with incidental impurities and having a microstructure of beta niobium second phase precipitates distributed uniformly intragranularly and intergranularly to form radiation resistant second phase precipitates in the alloy matrix. These radiation resistant second phase precipitates are alleged to give increased resistance to aqueous corrosion compared to that of Zircaloy when irradiated to high fluence. These zirconium alloys are intended for use in nuclear fuel rod cladding. Van Swam also explicitly states that binary zirconium-niobium alloys are susceptible to a type of nodular-like corrosion (Van Swam, column 1, lines 30-40).

In fabricating the cladding of Van Swam, a hollow tube is extruded. The extruded hollow tube is optimally annealed by heating for several hours and then subjected to a series of cycles of alternating pilgering and annealing steps to form the tube. After the last cycle of pilgering, the tubing is given a final heat treatment or anneal according to the desired condition of the tube as stress relieved, partially crystallized, or recrystallized.

Van Swam fails to disclose, teach, or suggest a method of producing a cladding tube for a nuclear pressure water reactor in which a tube is formed, the tube consisting of a cylindrical tube component of a zirconium-based alloy, where the alloying element, except for zirconium, which has the highest content in the alloy is niobium, wherein the niobium content in weight percent is between about 0.5 and about 2.4 and wherein no alloying

element, except for zirconium and niobium, in the alloy, has a content which exceeds about 0.2 weight percent, as recited in claim 24 and in claim 35. However, Van Swam explicitly states that binary zirconium-niobium alloys are susceptible to a type of nodular-like corrosion. The composition of Van Swam then incorporates 0.3-1.8 wt. % tin (Van Swam, column 4, lines 6-55; column 5, lines 19-31; and claim 1). Thus, Van Swam teaches away from the present invention because the alloy used in the present invention does not contain any element (except for zirconium and niobium) that exceeds 0.2%. Furthermore, Van Swam teaches away from the present invention because it utilizes the tin content to counter the effects of the nodular-like corrosion of the zirconium-niobium alloys, whereas the present invention as recited in claims 24 and 35 does not include tin and therefore does not rely on tin to counter the effects of nodular-like corrosion.

Furthermore, Van Swam fails to disclose, teach, or suggest that the final anneal is carried out such that the degree of recrystallization in the tube component is higher than about 40% and lower than about 95%, as recited in claims 24 and 35. Van Swam discloses three different kinds of final anneal treatment, but it does not indicate which of these three kinds of final anneal treatments is advantageous to use. Furthermore, Van Swam does not state that a certain one of these final anneal treatments should be used for a cladding tube for a pressure water reactor (PWR). Van Swam is directed to both boiling water reactors (BWR) as well as PWR, and in fact Van Swam explicitly states that the cladding tubes in question were tested in a BWR. However, it has not been suggested that a final anneal such that partial recrystallization is obtained should be used for a cladding tube for PWR of the kind of alloy specified in the claims. Consequently, Van Swam does not at all teach that partial recrystallization should be obtained. Moreover, Van Swam does not at all indicate that such a final anneal should be carried out such that the degree of recrystallization is between 40% and 95%. Additionally, Van Swam concerns a cladding tube of a completely different alloy that comprises a substantial amount of tin.

Because Van Swam fails to disclose, teach, or suggest what Applicants claim in their amended claims 24 and 35, namely, a method of producing a cladding tube for a nuclear pressure water reactor in which a tube is formed, the tube consisting of a cylindrical tube component of a zirconium-based alloy, where the alloying element, except for zirconium, which has the highest content in the alloy is niobium, wherein the niobium content in weight percent is between about 0.5 and about 2.4 and wherein no alloying element, except for

zirconium and niobium, in the alloy, has a content which exceeds about 0.2 weight percent, and in which the final anneal is carried out such that the degree of recrystallization in the tube component is higher than about 40% and lower than about 95%, Van Swam fails to teach all of the claim recitations of Applicants' invention. Consequently, because not all of the claim recitations are taught by the cited reference, Applicants' amended claims 24 and 35 are necessarily non-obvious, and Applicants respectfully request that the Examiner withdraw the rejections of claims 24 and 35.

Because claims 25 and 27-32 depend from claim 24, and because claim 24 is asserted to be non-obvious for the reasons presented above, claims 25 and 27-32 are necessarily non-obvious. Applicants, therefore, respectfully submit that claims 25 and 27-32 are allowable. Accordingly, Applicants respectfully request that the rejections of claims 25 and 27-32 be withdrawn. Also, because claims 37 and 38 depend from claim 35, and because claim 35 is asserted to be non-obvious for the reasons presented above, claims 37 and 38 are necessarily non-obvious. Applicants, therefore, respectfully submit that claims 37 and 38 are allowable. Accordingly, Applicants respectfully request that the rejections of claims 37 and 38 be withdrawn.

Claims 33, 34, 39, and 40 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Van Swam as applied to claim 24 with evidence from a journal article entitled "Zirconium Analysis by Production Control Quantometer" by Easterday.

Claims 33 and 34 depend from claim 24, and claims 39 and 40 depend from claim 35.

Because claims 33 and 34 depend from claim 24, and because claim 24 is asserted to be non-obvious for the reasons presented above, claims 33 and 34 are necessarily non-obvious. Applicants, therefore, respectfully submit that claims 33 and 34 are allowable. Accordingly, Applicants respectfully request that the rejections of claims 33 and 34 be withdrawn. Furthermore, because claims 39 and 40 depend from claim 35, and because claim 35 is asserted to be non-obvious for the reasons presented above, claims 39 and 40 are necessarily non-obvious. Applicants, therefore, respectfully submit that claims 39 and 40 are allowable. Accordingly, Applicants respectfully request that the rejections of claims 39 and 40 be withdrawn.

Claims 41 and 42 have been rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 3,607,639 to Van Santen et al. (hereinafter "Van Santen") in view of Van Swam. The Examiner alleges that it would have been obvious to one of ordinary skill in

the art at the time the invention was made to utilize the zirconium-based alloy tube, as disclosed by Van Swam, in the fuel assembly comprising a top plate, a bottom plate, spacer elements for maintaining the rods at suitable distances from each other, as allegedly disclosed by Van Santen, in order to increase resistance to aqueous corrosion as disclosed by Van Swam.

Van Santen discloses a fuel assembly for nuclear reactors. Such a fuel assembly is formed of a plurality of substantially parallel fuel rods arranged between a top plate and a bottom member inside a sheathing tube. Spacer element groups for the tubes are provided to keep the fuel rods in position. Each spacer element group comprises a number of spacer elements arranged in a spacer frame. The spacer frame is centered in the sheathing tube using a spring means carried by the spacer frame.

Van Santen fails to disclose, teach, or suggest a fuel assembly for a nuclear pressure water reactor, the fuel assembly comprising a plurality of cladding tubes, each having a generally cylindrical tube component of a zirconium-based alloy, wherein the alloying element, except for zirconium, having the highest content in the alloy is niobium, wherein the niobium content in weight percent is between about 0.5 and about 2.4 and wherein no alloying element, except for zirconium and niobium, in the alloy, has a content which exceeds about 0.2 weight percent, as recited in claim 41. The Examiner admits that Van Santen does not specify the all possible zirconium alloy compositions that would be used for the tube. Accordingly, Van Santen does not disclose the zirconium-niobium alloy composition as recited in claim 41.

Furthermore, it should be noted that Van Santen is not at all relevant to the subject matter of the claims as they currently stand because this document clearly relates to a BWR. A fuel assembly for a BWR typically has an outer casing that encloses the fuel assembly, as is shown in the Figures of Van Santen. Therefore, Van Santen fails to relate to a fuel assembly for a PWR as recited in claim 41.

The teachings of Van Swam are presented above.

Van Swam fails to disclose, teach, or suggest such a fuel assembly, as recited in claim 41, for reasons analogous to the reasons that it does not disclose, teach, or suggest the method and cladding tube of claims 24 and 35, respectively. This means that the combination of Van Swam and Van Santen also does not lead one of ordinary skill in the art to the subject matter recited in claim 41 as alleged by the Examiner.

Also, any combination of Van Santen and Van Swam also fails to disclose, teach, or suggest the fuel assembly as recited in claim 41 because the combination of Van Santen and Van Swam would still include tin (as in Van Swam) to counter the effects of nodular-like corrosion.

Because Van Santen fails to disclose, teach, or suggest what Applicants claim in their amended claim 41, namely, a fuel assembly for a nuclear pressure water reactor, the fuel assembly comprising a plurality of cladding tubes, each having a generally cylindrical tube component of a zirconium-based alloy, wherein the alloying element, except for zirconium, having the highest content in the alloy is niobium, wherein the niobium content in weight percent is between about 0.5 and about 2.4 and wherein no alloying element, except for zirconium and niobium, in the alloy, has a content which exceeds about 0.2 weight percent, as recited in claim 41, Van Santen fails to teach all of the claim recitations of Applicants' invention. Furthermore, because Van Swam fails to disclose, teach, or suggest such a fuel assembly, Van Swam fails to teach all the claim recitations of Applicants' invention. Moreover, because both Van Santen and Van Swam individually fail to disclose, teach, or suggest the fuel assembly, any combination thereof necessarily cannot teach all the recitations of Applicants' amended claim 41. Consequently, because not all of the claim recitations are taught by the cited references, individually or in combination, Applicants' amended claim 41 is necessarily non-obvious, and Applicants respectfully request that the Examiner withdraw the rejection of claim 41.

Claims that depend from a claim that is non-obvious are themselves necessarily non-obvious. Because claim 42 depends from claim 41, and because claim 41 is asserted to be non-obvious for the reasons presented above, claim 42 is necessarily non-obvious. Applicants, therefore, respectfully submit that claim 42 is allowable. Accordingly, Applicants respectfully request that the rejection of claim 42 be withdrawn.

Claims 41 and 42 have also been rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,323,434 to Lorek et al. (hereinafter "Lorek") in view of Van Swam. The Examiner alleges that it would have been obvious to one of ordinary skill in the art at the time of the invention to utilize the zirconium-based alloy tube, as allegedly disclosed by Van Swam, in the fuel assembly as allegedly disclosed by Lorek in order to increase resistance to aqueous corrosion as disclosed by Van Swam.

Lorek discloses a fuel assembly for a boiling water nuclear reactor. This fuel assembly includes a plurality of vertical fuel rods arranged between top and bottom tie plates in a surrounding vertical casing part. The fuel rods extend through spacers arranged in spaced relationships with the tie plates and are thereby retained in a spaced relationship in the lateral direction. As with Van Santen, the Examiner notes that Lorek does not specify all possible zirconium alloy compositions that would be used for the tube.

Lorek fails to disclose, teach, or suggest a fuel assembly for a nuclear pressure water reactor, the fuel assembly comprising a plurality of cladding tubes, each having a generally cylindrical tube component of a zirconium-based alloy, wherein the alloying element, except for zirconium, having the highest content in the alloy is niobium, wherein the niobium content in weight percent is between about 0.5 and about 2.4 and wherein no alloying element, except for zirconium and niobium, in the alloy, has a content which exceeds about 0.2 weight percent, as recited in claim 41. Again, the Examiner admits that Lorek does not specify all possible zirconium alloy compositions that would be used for the tube. Accordingly, Lorek does not disclose the zirconium-niobium alloy composition as recited in claim 41.

The teachings of Van Swam are presented above.

Also, Van Swam fails to disclose, teach, or suggest such a fuel assembly, as recited in claim 41, for reasons analogous to the reasons that it does not disclose, teach, or suggest the method and cladding tube of claims 24 and 35, respectively. This means that the combination of Lorek and Van Swam also does not lead one of ordinary skill in the art to the subject matter recited in claim 41 as alleged by the Examiner.

Any combination of Lorek and Van Swam also fails to disclose, teach, or suggest the fuel assembly as recited in claim 41 because the combination of Lorek and Van Swam would still include tin (as in Van Swam) to counter the effects of nodular-like corrosion.

Because Lorek fails to disclose, teach, or suggest what Applicants claim in their amended claim 41, namely, a fuel assembly for a nuclear pressure water reactor, the fuel assembly comprising a plurality of cladding tubes, each having a generally cylindrical tube component of a zirconium-based alloy, wherein the alloying element, except for zirconium, having the highest content in the alloy is niobium, wherein the niobium content in weight percent is between about 0.5 and about 2.4 and wherein no alloying element, except for zirconium and niobium, in the alloy, has a content which exceeds about 0.2 weight percent,

as recited in claim 41, Lorek fails to teach all of the claim recitations of Applicants' invention. Furthermore, because Van Swam fails to disclose, teach, or suggest such a fuel assembly, Van Swam fails to teach all the claim recitations of Applicants' invention. Moreover, because both Lorek and Van Swam individually fail to disclose, teach, or suggest the fuel assembly, any combination thereof necessarily cannot teach all the recitations of Applicants' amended claim 41. Consequently, because not all of the claim recitations are taught by the cited references, individually or in combination, Applicants' amended claim 41 is necessarily non-obvious, and Applicants respectfully request that the Examiner withdraw the rejection of claim 41.

As stated above with regard to the rejection of claims 41 and 42 over Van Santen in view of Van Swam, claims that depend from a claim that is non-obvious are themselves necessarily non-obvious. Because claim 42 depends from claim 41, and because claim 41 is asserted to be non-obvious for the reasons presented above, claim 42 is necessarily non-obvious. Applicants, therefore, respectfully submit that claim 42 is allowable. Accordingly, Applicants respectfully request that the rejection of claim 42 be withdrawn.

In view of the foregoing arguments, not only do the cited references teach away from the present invention as claimed, but the inventors have discovered a particular problem that is prevented by the present invention but not presented by the methods and devices of the cited art. This particular problem is the formation of radial hydrides in the cladding tube (as described in the present application in paragraph [0009]). The inventors have surprisingly discovered that the formation of such hydrides in the radial direction can to a large extent be avoided by the present invention, since by the specific final anneal (by which a degree of recrystallization between 40% and 95% is obtained) possible hydrides will extend mainly in a tangential direction. Thereby an improved resistance against crack formation is obtained. None of Van Swam, Van Santen, and Lorek indicate the possibility of solving the problem of radial hydrides in the manner that the present invention recites in the claims.

Applicants believe that the foregoing amendments and remarks are fully responsive to the Office Action and that the claims herein are allowable. An early action to that effect is earnestly solicited.

If the Examiner believes that a telephone conference with Applicants' attorneys would be advantageous to the disposition of this case, the Examiner is invited to telephone the undersigned.

Applicants believe that no fees are due with the submission of this Amendment. If any charges are incurred with respect to this Amendment, they may be charged to Deposit Account No. 503342 maintained by Applicants' attorneys.

Respectfully submitted,

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